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Informing the Design of a Robotic Coach through Systematic Observations

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ABSTRACT

Current physical rehabilitation techniques can be boring and frustrating for those that need them, especially when they are carried out alone over the long-term. Individual, repetitive exercises are also carried out by high performance athletes in sports such as squash. By observing the motivational behaviours used by professional squash coaches, we have analysed coaching styles which will help to inform the design of an autonomous robotic coach capable of increasing adherence to a long-term sports or rehabilitation exercise program.

CCS CONCEPTS

• General and reference~Cross-computing tools and techniques~design • Human-centred computing~Human computer interaction (HCI)

KEYWORDS

Systematic observations; Motivation; Autonomous robotic coach

1 Introduction

Rehabilitation after physical traumas such as stroke and falls, and for medical conditions such as Cerebral Palsy involves task specific, repetitive practice over a long period of time [1]–[3]. However, current techniques have been shown to elicit boredom and frustration in survivors [4]. Repetitive exercises and drills are also used in individual practice for high performance sports such as squash. Praise for independent practice given by sports coaches can increase the intrinsic motivation of the athlete [5], which is a contributing factor towards their desire to continue practicing and improving in the sport [6].

Sussenbach *et al.* showed the potential of using an autonomous robotic system to engage a user in an individual exercise routine [7]. By first creating a motivational model based on observations of human-human interaction, a robotic cycling instructor was created which elicited better training effects, more intensive workouts and higher training motivation in participants compared to a textual control system. The potential also exists for a robot to lead a user through a stroke rehabilitation program, although this has only been evaluated with a short term, lab-based study [8]. It would be possible for an autonomous robot of this kind to provide specific feedback on a physical rehabilitation exercise [9]. However, the best way of providing this feedback through an HRI system remains unknown. This work will build on [7] by using a different observation technique on coaches.

Systematic observation is seen by the sports coaching research community as a valuable tool in furthering one's understanding of what coaches do in practice and competition [10]. However, in a recent review of the literature Cope *et al.* identified only one study between 1997 and 2016 which observed coaches' behaviours in an individual sport (golf) [10]. It is in individual sports that the biggest parallels can be seen with long term rehabilitation. Therefore, a systematic observation study was undertaken in the current work to gather data on the most prominent behaviours used by professional squash coaches. One potential approach to interpreting this data is given in the form of behaviour graphs. The coaching styles visualised in these behaviour graphs could be a starting point for a reinforcement learning (RL) algorithm to learn the best way to motivate an individual, thus developing the ideas presented in [7] and [8] by personalising the user experience.

2 Method

Each coach was observed live for two full sessions, each lasting between 22 and 56 minutes. The first 5 sessions of the study were also filmed to obtain intra-observer reliability and conduct the necessary coder training (see Section 2.1). The coach completed a short demographic questionnaire before the session began.

Participants were asked to carry out a one-to-one coaching session as normal while they were observed by the researcher. As the session progressed, the researcher completed the observation instrument in the manner detailed in Section 2.1, giving the total occurrences of each behaviour and the order in which they occurred. Each session was timed to the nearest 5 seconds so that the frequency of behaviours could be calculated.

2.1 Observation Instrument

The observation instrument (completed using a version of event recording [11]) used was a modified version of the Arizona State

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University Observation Instrument (ASUOI) [11]. The new instrument was developed in consultation with an experienced coder (has authored and reviewed related works [12], [13]) and a professional squash coach. The observer (first author) was also trained in the use of the instrument by the experienced coder, as recommended by [10]. The final instrument contained 16 behavioural categories and was adapted from the original as follows: 3 behavioural categories were added - console, positive reinforcement, and punishment; 2 removed - silence and management; and 2 altered - concurrent instruction and post instruction were both split into positive and negative versions.

2.2 Participants

With the help of Scottish Squash (the sport's national governing body in Scotland) and through contacts of the first author, 8 professional squash coaches were recruited (6 male, 1 female, 1 preferred not to say). Their ages ranged from 25-63 (M = 41 ± 13). Each coach had at least 10 years of coaching experience, a minimum of level 2 coaching qualification from the Scottish national governing body, had worked with both junior and senior players and international or developmental players in the last year, and currently coached squash on at least a weekly basis.

Fifteen squash players (10 male, 5 female, aged 18-70, M = 32 ± 16) were also involved in the study but no data about them was collected directly. They ranged in experience playing squash from 2 years to 37 years (M = 11 years ± 9) and the time they had been working with the observed coach varied from 6 months to 10 years (M = 3.13 years ± 2.87).

3 Results

All observed coaches used more positive behaviours (e.g. praise, positive modelling, positive instruction) than negative behaviours (e.g. scold, negative modelling, negative instruction). The difference between the percentage of positive behaviours and negative behaviours ranged from 47.1% to 66.0% (M = 57.4%). The difference was less apparent in behaviours which occurred after play than during (concurrent instruction difference M = 20.8%, post-instruction difference M = 4.7%) indicating that in general, coaches preferred to wait until play had stopped (or stop play themselves) to say something negative.

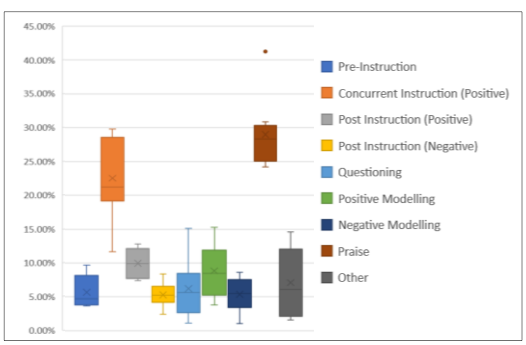

Figure 1: The distribution of coaches' behaviours. (Only categories accounting for more than 5% of coaches' combined behaviours are included.)

Praise was the most frequently used behaviour for 7/8 observed coaches, followed by positive concurrent instruction for 6 out of those 7. The other coach used positive concurrent instruction most frequently, followed closely by praise. No positive reinforcement (physical reward) or punishment (physical retribution) was observed in any of the coaches. Manual manipulation (M = 0.3%) and scold (M = 0.5%) were used very infrequently by all coaches.

Despite these similarities, there were noticeable differences in coaching styles, as shown in Figure 1. In particular, there was a wide variety in the amount of questioning, modelling, post instruction, and concurrent instruction used by the coaches.

As a starting point, these different coaching behaviours can be represented as behaviour graphs for each coach (Figure 2). With further analysis behaviour graphs of coaching styles could be produced, providing an internal model of coaching behaviour to be used and adapted by a robotic coaching system using RL.

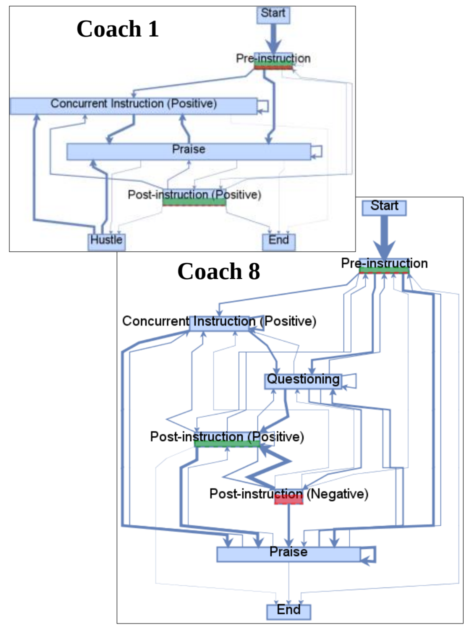

Figure 2: The behaviour graphs of observed coaches 1 and 8. The width of the box represents the amount of times that behaviour was used and the arrow represents a transition between behaviours. Green and red within a box represent concurrent positive and negative modelling respectively.

4 Conclusion

By conducting systematic observations of 8 professional squash coaches during one-to-one sessions, we found some similarities in the behaviours used by coaches (e.g. lots of praise and positive concurrent instruction). However there were also some striking differences, particularly in the amount of questioning and modelling used. By conducting further analysis on the behaviour graphs created, we can investigate these differences further with the aim of creating an autonomous robotic coach capable of motivating a user to adhere to a long-term individual sports or rehabilitation program.

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